THE CLAIMS

What Is Claimed Is:

1. A hydrogen gas detector for detection of hydrogen gas in a gaseous environment, said detector comprising a light/heat source, an optical detector, and an optical barrier therebetween, wherein the optical barrier responds to the presence of hydrogen by responsively changing from a first optical state to a different second optical state, whereby transmission of light from said light/heat source through said optical barrier is altered by the presence of hydrogen and said altered transmission is sensed by said optical detector to provide an indication of the presence of hydrogen gas in the gaseous environment.

2. The hydrogen gas detector of claim 1, wherein the first optical state comprises a state of optical opacity of the optical barrier.

3. The hydrogen gas detector of claim 1, wherein the second optical state comprises a state of optical non-opacity of the optical barrier.

4. The hydrogen gas detector of claim 1, wherein the second optical state comprises translucency/transparency of the optical barrier.

5. The hydrogen gas detector of claim 1, wherein the optical barrier comprises a rare earth metal thin film.

6. The hydrogen gas detector of claim 1, wherein the optical barrier comprises an yttrium thin film.

7. The hydrogen gas detector of claim 1, wherein the optical barrier comprises a rare earth metal thin film deposited on the optical output surface of the light/heat source, overlaid by a protective film that is permeable to hydrogen gas.

8. The hydrogen gas detector of claim 7, wherein the protective film comprises a palladium film.

9. The hydrogen gas detector of claim 7, wherein surface morphology roughness of the optical output surface of the light/heat source prior to deposition of the rare earth metal thin film has been increased by treatment of the optical output surface comprising a roughening step selected from the group consisting of mechanical roughening, chemical roughening, deposition of highly exfoliated or porous inorganic underlayers, and deposition of porous polymer underlayers, to thereby increase the response time of the rare earth metal thin film as compared with a corresponding unroughened optical output surface.

10. The hydrogen gas detector of claim 1, embodied as a unitary portable article.

11. The hydrogen gas detector of claim 1, further comprising a power supply.

12. The hydrogen gas detector of claim 11, wherein the power supply comprises a battery.

13. The hydrogen gas detector of claim 1, further comprising an output module operatively coupled to the optical detector, and arranged to provide an output alarm indicative of the presence or concentration of hydrogen gas in the gaseous environment.

14. The hydrogen gas detector of claim 13, wherein said output alarm is selected from the group consisting of visual, audible and tactile alarms.

15. The hydrogen gas detector of claim 1, wherein the light/heat source comprises a lamp element providing heat output incident to the generation of light.

16. The hydrogen gas detector of claim 1, wherein the light/heat source comprises an incandescent lamp.

17. The hydrogen gas detector of claim 16, wherein the incandescent lamp comprises a light-transmissive bulb, the exterior surface of which is coated with a rare earth metal thin film as said optical barrier.

18. The hydrogen gas detector of claim 1, wherein the light/heat source comprises an optical waveguide.

19. The hydrogen gas detector of claim 18, wherein optical output surface of said optical waveguide is coated with a rare earth metal thin film as said optical barrier.

20. The hydrogen gas detector of claim 18, wherein said optical barrier comprises a multi-layer structure deposited on the optical output surface of said optical waveguide, said multi-layer structure comprising at least a first and a second layer,

wherein the first layer absorbs optical energy of a first wavelength and is thereby heated while remaining transparent or translucent to optical energy of a second wavelength, and the second layer comprises a rare earth metal thin film, the optical properties of which are responsive to the presence and concentration of hydrogen gas in the surrounding environment.

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21. A hydrogen gas detector for detection of hydrogen gas in a gaseous environment, said detector comprising a light/heat source, at least one optical detector, and at least one optical barrier deposed between the light/heat source and each detector, wherein the optical barriers respond to the presence of hydrogen by responsively changing from a first optical state to a different second optical state, whereby transmission of light from said light/heat source through said optical barriers is altered by the presence of hydrogen and said altered transmission is sensed by said optical detectors to provide an indication of the presence and concentration of hydrogen gas in the gaseous environment.

22. The hydrogen gas detector of claim 21, wherein the light/heat source comprises an incandescent bulb, and the optical barriers comprise a single rare earth metal thin film coating the exterior surface of said bulb, with a plurality of protective layer sections overlaid on mutually exclusive portions of the rare earth metal thin film coating, wherein each protective layer section exhibits a unique permeability to hydrogen.

23. The hydrogen gas detector of claim 22, wherein the number of optical detectors exceeds the number of heat/light sources, and wherein each optical detector is arranged in light-receiving relationship with a heat/light source such that the

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luminous flux impinging each detector passes through only one of the plurality of protective layer sections.

24. The hydrogen gas detector of claim 23, further comprising a plurality of output modules, each of which is operatively coupled to an optical detector, and arranged to provide an output indicative of the concentration of hydrogen gas in the gaseous environment.

25. The hydrogen gas detector of claim 1, of a hand-held size and portable character.

26. The hydrogen gas detector of claim 1, wherein a plurality of heat/light sources, optical detectors, and optical barriers, each set of which is arranged in operative relationship to effect the detection of hydrogen gas in a gaseous environment, are further arranged in an array, and wherein each combination of heat/light source, optical detector, and optical barrier is configured to respond to a different concentration of hydrogen gas in the gaseous environment.

27. The hydrogen gas detector array of claim 26, further comprising a corresponding array of output modules operatively coupled to the optical detectors, and arranged to provide an output indicative of the concentration of hydrogen gas in the gaseous environment.

28. The hydrogen gas detector of claim 1, operatively coupled with corresponding hydrogen gas detectors to form an extended area monitoring system for detection of hydrogen gas in the gaseous environment of said extended area.

29. The hydrogen gas detector of claim 1, wherein the light/heat source comprises a lamp element providing heat output incident to the generation of light, with an yttrium thin film coated on said lamp element as said optical barrier, and a palladium film coated on the yttrium thin film.

30. A hydrogen gas detector, comprising

a light source;

~~a thermal energy source;~~

an optical filter having an optical transmissivity responsive to the presence and concentration of hydrogen gas in an ambient environment to which the optical filter is exposed, said optical filter being disposed in proximity to the light source such that said optical filter is illuminated with light from the light source, and being operatively coupled to the thermal source such that the optical filter is heated by the thermal source;

a light detector generating an output signal, the state of said output signal being proportional to the intensity of light impinging on the light detector, said light detector being disposed in light-sensing relationship to the optical filter, whereby light from the light source passing through the optical filter impinges on the light detector and generates said output signal as a indication of the presence and/or concentration of hydrogen gas in the ambient environment.

31. The hydrogen gas detector of claim 30, wherein the source of luminous energy comprises a light-generating element selected from the group consisting of incandescent bulbs, light emitting diodes, fluorescent lamps, electroluminescent lamps, and optical lasers, and optical waveguides illuminated by any such light-generating element.

32. The hydrogen gas detector of claim 30, wherein the thermal energy source comprises a heat-generating element selected from the group consisting of incandescent bulbs, resistive wires, exothermic chemical reactions, ultrasonic radiation, acoustic radiation, microwave radiation, and laser radiation.

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33. The hydrogen gas detector of claim 30, wherein the light source and the thermal energy source comprise a same element.

34. The hydrogen gas detector of claim 30, wherein light source and the thermal energy source comprise different elements.

35. The hydrogen gas detector of claim 30, wherein the light detector comprises a light detection element selected from the group consisting of photodiodes, avalanche photodiodes, phototubes, photomultiplier tubes, microchannel plates, solar cells, image intensifiers, photoconductor detectors, charge-coupled devices, and combinations or arrays thereof.

36. The hydrogen gas detector of claim 30, wherein the optical filter comprises a rare earth metal thin film deposited on an optical output surface of the light source.

37. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film comprises a rare earth metal component selected from the group consisting of trivalent rare earth metals reactive with hydrogen to form both metal dihydride and metal trihydride reaction products, wherein the metal dihydride and metal trihydride reaction products have differing optical transmissivity.

38. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film comprises at least one metal selected from the group consisting of:

(I) scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium,

(II) alloys thereof, and

(III) alloys containing one or more of such metals alloyed with an alloying component selected from the group consisting of magnesium, calcium, barium, strontium, cobalt and iridium.

39. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film comprises yttrium.

40. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film is overlaid by a hydrogen-permeable material comprising a metal selected from the group consisting of Pd, Pt, Ir, Ag, Au, Ni, Co, and alloys thereof.

41. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film is overlaid in sections by a plurality of hydrogen-permeable material, each comprising a metal selected from the group consisting of Pd, Pt, Ir, Ag, Au, Ni, Co, and alloys thereof, wherein each overlay section exhibits a unique permeability to hydrogen.

42. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film is overlaid by a hydrogen-permeable material that is doped with a dopant selected from the group consisting of Mg, Ca, Al, Ir, Ni and Co.

43. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film is overlaid in sections by a plurality of hydrogen-permeable materials, each of which is doped with a dopant selected from the group consisting of Mg, Ca, Al, Ir, Ni and Co, wherein each overlay section exhibits a unique permeability to hydrogen.

44. The hydrogen gas detector of claim 36, wherein the rare earth metal thin film is overlaid by a thin film of a material including a metal selected from the group consisting of palladium, platinum, and iridium.

45. A hydrogen detection system for monitoring an extended or remote area region for the incursion or generation of hydrogen therein, said hydrogen detection system comprising a multiplicity of hydrogen gas detector elements each of which (i) is arranged for exposure to a specific individual locus of the extended area region and (ii) employs an optical filter comprising a rare earth metal thin film that exhibits a detectable change in optical transmissivity when the rare earth metal thin film is contacted with hydrogen at said locus.

46. A method of fabricating a hydrogen gas detector, comprising:

providing a source of luminous and thermal energy including an output surface for emitting light and thermal energy;

depositing on the output surface an optical filter comprising a rare earth metal thin film that responds to contact with hydrogen by exhibiting a detectable change of optical transmissivity;

positioning a light detector in light-sensing proximity to the source of luminous and thermal energy, whereby a change in optical transmissivity of the rare earth metal thin film in exposure to hydrogen gas is detected as a change in luminous energy flux impinging on the detector, and

outputting a signal indicative of said change in luminous energy flux.

47. The method according to claim 46, wherein the rare earth metal thin film is formed on the output surface of the source of luminous and thermal energy, by a technique selected from the group consisting of physical vapor deposition, chemical vapor deposition, sputtering, solution deposition, focused ion beam deposition, pulsed laser deposition, electrolytic plating, and electroless plating.

48. The method according to claim 46, wherein the rare earth metal thin film is formed on the substrate by physical vapor deposition.

49. The method according to claim 46, wherein the rare earth metal thin film is formed on the substrate by chemical vapor deposition using an organometallic precursor that thermally decomposes to the metal hydride or elemental metal in a reducing environment of hydrogen.

50. The method according to claim 46, wherein the outputting step comprises generating an output selected from the group consisting of visual outputs, optical outputs, tactile outputs, electrical outputs and auditory outputs.

51. The method according to claim 46, wherein the rare earth metal thin film comprises at least one metal selected from the group consisting of:

(I) scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium,

(II) alloys thereof, and

(III) alloys containing one or more of such metals alloyed with an alloying component selected from the group consisting of magnesium, calcium, barium, strontium, cobalt and iridium.

52. The method according to claim 46, wherein the rare earth metal thin film comprises a rare earth metal component selected from the group consisting of trivalent rare earth metals reactive with hydrogen to form both metal dihydride and metal trihydride reaction products, and wherein the metal dihydride and metal trihydride reaction products have differing optical transmissivity, and wherein transitions between the metal dihydride and metal trihydride reaction products are caused by the presence or absence of hydrogen gas contacting the rare earth metal thin film.

53. The method according to claim 46, wherein the rare earth metal thin film is overlaid by a hydrogen-permeable material comprising a metal selected from the group consisting of Pd, Pt, Ir, Ag, Au, Ni, Co, and alloys thereof.

54. The method according to claim 46, wherein the rare earth metal thin film is overlaid by a hydrogen-permeable material that is doped with a dopant selected from the group consisting of Mg, Ca, Al, Ir, Ni and Co.

55. The method according to claim 46, wherein the rare earth metal thin film is overlaid by a thin film of a material including a metal selected from the group consisting of palladium, platinum, and iridium.

56. The method according to claim 46, wherein the rare earth metal thin film comprises yttrium.

57. The method according to claim 46, wherein the rare earth metal thin film comprises a metal selected from the group consisting of lanthanum and yttrium, and the rare earth metal thin film is formed on the output surface of the source of luminous and thermal energy by CVD utilizing a corresponding precursor, wherein said precursor is selected from the group consisting of tris(cyclopentadienyl)lanthanum, tris(cyclopentadienyl)yttrium, ß-diiminate complexes of lanthanum, ß-diiminate complexes of yttrium, lanthanum amides, and yttrium amides.

58. The method according to claim 46, wherein the rare earth metal thin film comprises lanthanum, and the rare earth metal thin film is formed on the substrate by CVD utilizing a precursor, wherein said precursor is selected from the group consisting of $La(NR_2)3$, $La(NR_2)_3{\cdot}L$, $La(R)_3$ and $La(R)_3{\cdot}L$, wherein R is selected from the group consisting of C_1 to C_8 alkyl and C_1 to C_8 aryl and L is a Lewis base ligand selected from the group consisting of amines, aryls and aryl amines.

59. The method according to claim 58 wherein the Lewis base ligand is selected from the group consisting of NH3, primary amines, secondary amines, tertiary amines, polyamines.

60. The method according to claim 59 wherein the Lewis base ligand is selected from the group consisting of pyridine, methylamine, dimethylamine trimethylamine,

dimethylethylamine, *N,N,N',N'*-tetramethylethylenediamine and *N,N,N',N',N''*-pentamethyldiethylenetriamine.

61. The method according to claim 46, wherein the rare earth metal thin film comprises yttrium, and the rare earth metal thin film is formed on the substrate by CVD utilizing a precursor, wherein said precursor is $Y(NSiR'_3)_3$, wherein R' is selected from the group consisting of C_1 to C_8 alkyl and C_1 to C_8 aryl.

62. The method according to claim 46, wherein the rare earth metal thin film has deposited thereon an overlayer comprising palladium, and said overlayer is formed by chemical vapor deposition on the rare earth metal thin film using a palladium precursor selected from the group consisting of $Pd(hfac)_2$, $Pd(allyl)_2$, CpPd(allyl), Pd(allyl)(hfac), $COD{\cdot}Pd(Me)_2$ and Pd(methylallyl)(hfac).